

Do gestures during training facilitate L2 lexical stress acquisition by Dutch learners of Spanish?

Lieke van Maastricht¹, Marieke Hoetjes,¹ Ellen van Drie¹

¹Centre for Language Studies, Radboud University, Nijmegen

l.vanmaastricht@let.ru.nl, m.hoetjes@let.ru.nl, e.vandrie@student.ru.nl

Abstract

The close relationship between speech and gesture has led to a range of studies focusing on the role of gesture in L1 and L2 language acquisition. However, few studies focused specifically on the acquisition of prosodic aspects of speech, and those that did, did not compare the possible effect of different types of gestures. Thus, this paper aims to determine whether seeing beat or metaphoric gestures during training facilitates L2 lexical stress acquisition as compared to seeing no gestures during training. Dutch participants received Spanish lexical stress training in one of three multimodal conditions and produced sentences containing cognates with diverging stress distribution in Dutch and Spanish before and afterwards. The results appear in line with our predictions in that learning proportions are higher after gestural training than after training without gestures and again higher after training with metaphoric gestures compared to training with beat gestures. However, a multinomial regression analysis reveals that only the presence vs. absence of a written accent in the cognate significantly affects L2 lexical stress acquisition. Hence, several factors are proposed that might explain our results and serve as a basis for future research.

Index Terms: multimodality; lexical stress; gesture; Dutch; Spanish.

1. Introduction

Studies on language development, production, and comprehension have demonstrated that speech and co-speech gestures are integrated in communication [1, 2, 3]. Gestures are also known to facilitate non-linguistic learning [e.g., 4], L1 acquisition [5, 6], as well as certain aspects of L2 acquisition, such as novel word learning [7, 8]. As accurate segment and prosody production contributes to L2 learners' intelligibility, comprehensibility and accentedness [9, 10, 11], research on the interplay between gestural and verbal input in this domain is especially relevant. However, regarding the benefits of gestures in the acquisition of L2 sounds, prior work presents contrasting results: Some studies find that gestures seen or produced during training facilitate the learning of both L2 segments and prosodic features [e.g., 12, 13], others find no effect or report contexts in which gestures might even be unhelpful [14, 15, 16]. One possible reason for these contradicting results may be the type of gesture that is used during training. The aforementioned studies often vary in the gesture types used in training (e.g., beats, metaphoric gestures, iconic gestures, pointing gestures, and even hand clapping) and usually do not allow for a comparison of the effect of these different kinds of gestures. Hence, in our experiment, we investigate the potential benefit of two types of gestures during training in L2 lexical stress production. To this end, Dutch learners of Spanish received training on Spanish

lexical stress placement in one of three conditions: audio-visual without gestures (AV), audio-visual with beat gestures (AV-B), or audio-visual with metaphoric gestures (AV-M). Before and after training, participants read short Spanish sentences containing cognates that differed in the position of the stressed syllable (e.g., 'piramides' and 'ventilator' in Dutch, but 'pirámides' and 'ventilador' in Spanish).

Before turning to the method of our study, we review prior research on the relationship between gesture and prosody in the expression of prominence. Co-speech gestures used in natural interaction are closely related to speech prominence [17, 18, 19, 20], a linguistic property that in many languages is also (partially) represented prosodically. Especially beat gestures have been shown to be temporarily aligned with prominence in speech [2, 21], and Krahmer and Swerts [18] found that seeing a beat gesture increases the perceived prominence of a word. Given the close relationship between gesture and prominence, the potential of gestures as a visualisation tool in the acquisition of the relative prominence of L2 syllables seems intuitive. However, there are not many studies that looked into the facilitating role that gestures may play in L2 prosody acquisition. Gluhareva and Prieto [22] investigated the effects of beat gestures in a short training on L2 rhythm using a within-participants design. Catalan learners of English were presented with videos showing a native speaker of English replying to discourse prompts either with or without accompanying beat gestures. Replies from the participants to the native speaker before and after training were rated on accentedness. The results showed that participants' accentedness ratings benefited significantly from the videos with gestures, but only in the case of difficult items.

Zheng, Hirata and Kelly [23] used training videos on monosyllabic words to explain Chinese lexical tonal differences to L1 and L2 speakers of Mandarin. The videos included either speech without gestures, speech in combination with head nods or speech with metaphoric gestures visualising the pitch contour of the word. Participants were asked to imitate what they had heard and seen and their speech was rated on accentedness. The authors conclude that metaphoric gestures play only a very modest role in learning the pitch contours, but they could give 'a small boost' to learning for novice, but not expert, learners.

Finally, Zhang, Baills and Prieto [24] investigated the benefits of hand clapping in a lexical stress training for Chinese learners of French. They compared a group that watched a video in which someone used handclapping to mark the prominence of syllables with a group that watched videos without clapping. The participants were tested using an imitation task before and after training, repeating the words with or without clapping themselves. The results revealed no significant effects for accentedness ratings, but an analysis of the relative syllable duration did show a significant improvement between pre and post-test for the clapping condition.

In sum, prior research on the use of gestures in L2 prosody training reveals that different types of gestures affect L2 learners' productions to different degrees, also depending on the difficulty of the task. Hence, two different kinds of gestures are compared in the present study; one with a supposedly relatively low processing load, as well as less semantic meaning, but which has been shown to be related to rhythmic prominence (beat), and one with a clear semantic meaning and therefore possibly a higher processing load, but which is less clearly related to rhythmic prominence (metaphoric gesture expressing duration) [25, 26]. In addition, we limit the difficulty of the learning task by using cognates. In [24], the meaning of the newly learned French words was not transparent to the Chinese learners, which entails that participants were perhaps also focused on learning the meaning of the word, as well as the correct pronunciation.

Thus, our research question is: Does instruction modality affect L2 learners' production of non-native lexical stress? We hypothesize: 1) Given that the use of gestures is helpful in the acquisition of certain segments [16, 27], as well as suprasegments [22, 24], using gestures in the audio-visual training will be more beneficial than not including them. 2) Participants might benefit more from a metaphoric gesture than from a beat gesture during L2 lexical stress training. This expectation is based on [28], which is the only study to our knowledge that has compared the effect of different types of gestures, albeit in the context of L2 segment acquisition. Their results imply that a simple gesture (in their case pointing) is more beneficial for relatively difficult contexts, while a more complex gesture (in their case an iconic one) is more helpful in relatively easy contexts. Applying these results to the current design suggests that given the use of cognates to facilitate the task, participants might benefit more from a metaphoric gesture than from a beat gesture during L2 lexical stress training.

2. Method

This study had a between-subjects pre-test (T1) and post-test (T2) design in which participants took part in one of three training conditions: audio-visual without gestures (AV), audio-visual with beat gestures (AV-B), or audio-visual with metaphoric gestures (AV-M). The placement of lexical stress in the target words, coded as either on-target or not, was used as the dependent variable.

2.1. Participants

Sixty-two adult L1 speakers of Dutch (46 female, 16 male), with an average age of 25 years old (range 18-65 years old) took part in the study. Participants did not speak Spanish, reported not to have been in contact with Spanish L1 speakers for substantial periods and had no auditory or visual impairments that could affect their participation. They were recruited via the university research participation system and received either credits or a small financial reward for their participation.

2.2. Materials

2.2.1. Sentences

In this study, we focused on the L2 production of Spanish lexical stress, as produced by participants in the same set of twenty-eight easy to parse four-word Spanish sentences at T1 and T2 in one of two randomised orders. Each sentence was presented on a separate PowerPoint slide accompanied by a picture

illustrating the meaning of the sentence, to help participants further understand the semantic meaning of the sentence, and to make the task more interesting (see Figure 1). Half of the sentences were experimental items that contained a cognate in which a different syllable is stressed than in its Dutch counterpart, either with a written accent (e.g., in Spanish: *Los cardiólogos son inteligentes* vs. in Dutch: *De cardiologen zijn intelligent*) or without a written accent (e.g., in Spanish: *El radiador es moderno* vs. in Dutch: *De radiator is modern*). The other half of the sentences were filler items that contained a cognate in which the same syllable is stressed in its Dutch counterpart, either with a written accent (e.g., in Spanish: *Los números son romanos* vs. in Dutch: *De nummers zijn Romeins*) or without a written accent (e.g., in Spanish: *La universidad es grande* vs. in Dutch: *De universiteit is groot*). The cognate always appeared as the second word of the sentence. For this paper, the filler items were not analysed.



Figure 1: Example of an experimental item containing the cognate 'máquina'.

2.2.2. Training

After T1, the participants received a short training explaining Spanish lexical stress. Specifically, participants were informed that lexical stress in Spanish is governed by three rules: 1) Words with no written accent ending in a vowel, an -n, or an -s have penultimate syllable stress; 2) Words with no written accent ending in a consonant that is not -n or -s have final syllable stress; and 3) In words with a written accent, stress is placed on the syllable with the accent. The training included one example per rule, produced by an L1 speaker of Spanish. The manipulation of the training modality consisted of the fact that the examples were presented in either the AV, AV-B, or AV-M condition. The same audio (from the L1 speaker seen in the video) was dubbed over all conditions, but they differed with regard to the video material that was presented: In the AV condition, a video of the speaker was shown, but the speaker did not move her body, apart from her mouth. In the AV-B condition, the speaker made a beat gesture while producing the stressed syllable. She placed the palms of her hands together and then moved one hand up and back down with the end of the downward stroke aligned with the stressed syllable (see Figure 2). In the AV-M condition, the speaker made a metaphoric gesture as she produced the stressed syllable. This gesture represented the lengthening of the syllable needed for on-target lexical stress production as duration is the most important correlate with lexical stress in Spanish [29, 30]. The speaker started again with her palms together, then moved both hands to the side, outwards, and then back together (see Figure 3). The timing of the hands moving outwards was aligned with the start of the stressed syllable.



Figure 2: Stills from training video in AV-B condition showing an example of a beat gesture.



Figure 3: Stills from training video in AV-M condition showing an example of the metaphoric gesture.

2.3. Procedure

The experiment took place in a sound-proof booth to minimize distractions. Participants signed a consent form and then took part in the experiment, which was self-paced. Written and verbal instructions were given, followed by a practice sentence and the opportunity to ask questions. Participants were then asked to read out the twenty-eight Spanish sentences into a microphone (T1). They were allowed to repeat the sentence until they were satisfied with their production; the final attempt was used for analysis. After T1, a language background questionnaire was administered and after receiving one of the three types of training, participants reread the same sentences as during T1, albeit in a different order (T2). The audio produced by participants during T1 and T2 was recorded, and production of the target phonemes was analysed with Praat (version 6.0.43, [31]). The entire experiment, with the exception of the Spanish sentences, took place in Dutch.

2.4. Analyses

First, all sentences containing the target words, that is both experimental items and fillers (28 T1 + 28 T2 words \times 62 participants = 3472 words), were extracted from the sound files. The target words were then coded as either an on-target production (i.e., with lexical stress placed according to the stress rules of Spanish) or not on-target (i.e., stress being placed on a different syllable) by two phonetically trained coders, with an overlap in coding of 40%. The interrater reliability was almost perfect, $\kappa = .944$, $p < .001$.

Annotations for the same experimental items (i.e., fillers excluded) were compared between T1 and T2, and recoded as to whether the participant was able to produce the target phoneme at T1, but not anymore at T2 (Unlearning); was not able to produce the target phoneme at either T1 or T2 (Never Able); was able to pronounce the target phoneme at both T1 and T2 (Always Able); or was unable to produce the target phoneme at T1, but able to do so at T2 (Learning).

3. Results

Visual inspection of the proportional results per training outcome reveals that the results appear in line with our expectations: the proportion of learning increases between the AV and the AV-B condition, and again between the AV-B and A-M condition, suggesting that more learning takes place after AV-B training than after AV training without gestures, as well as more learning occurring after AV-M training than AV-B training (see Figure 4). In addition, in the cases where learning took place, the presence or absence of a written accent does not appear to affect the outcome, while the majority of the items that participants were never able to learn contained a written accent and the reverse held for the cases in which participants were already able to produce an item; this was mostly the case for items without a written accent.

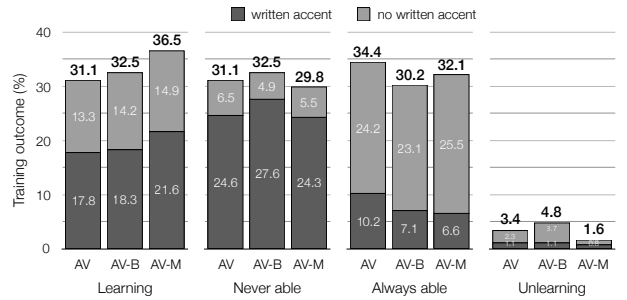


Figure 4: Relative training outcome per gesture condition, separated by items with and without a written accent.

A multinomial logistic regression analysis was then performed to model the relationship between both gesture condition (AV, AV-B, AV-M) and whether the word had a written accent (WA) or not (NWA), and learning outcome (Learning, Never Able, Always Able, Unlearning). Addition of the predictors to the model that contained only the intercept significantly improved the fit between model and data, $\chi^2(9) = 189,125$, $p < .001$. As shown in Table 1, a significant unique contribution was made only by whether the item had a written accent or not.

Table 1: Likelihood ratio tests

Predictor	X ²	Df	p
Gesture condition	6.95	6	.352
Written accent	182.28	3	.000

Learning was taken as the base category. Accordingly, each predictor had 3 parameters (see Table 2), one for predicting the odds to Unlearn rather than Learn (1), one for Never being able rather than Learning (2), and one for Always being able rather than Learning (3). The analysis shows that the main predictor for learning outcome was whether the cognate had a written accent or not. More specifically, for items with no written accent, the odds increased for Unlearning (1) and Always being able (3) rather than Learning compared to items with a written accent. For items with no written accent, the odds decreased to Never being able rather than Learning (2) as compared to items with a written accent.

Table 2: *Parameter estimates*

	<i>b</i> (<i>SE</i>)	95% CI for Odds Ratio		
		Lower	Odds Ratio	Upper
(1)				
AV	.96 (.62)	.77	2.60	8.81
AV-B	1.25 (.59) *	1.09	3.49	11.17
NWA	1.12 (.45) *	1.29	3.08	7.36
(2)				
AV	.18 (.23)	.77	1.20	1.87
AV-B	.20 (.22)	.79	1.22	1.88
NWA	-1.12 (.21) **	.20	.298	.45
(3)				
AV	.25 (.23)	.83	1.29	2.00
AV-B	.06 (.23)	.68	1.06	1.65
NWA	1.42 (.19) **	2.84	4.14	6.03

Note: In the model, the dependent variable is learning outcome, in which Learning is taken as the base category. Explanatory variables include audio-visual with metaphoric gestures (AV-M), and written accent (WA) as reference categories. ** = $p < .001$, * = $p < .05$.

4. Discussion

The aim of this study was to determine whether the use of gestures during training affects L2 learners' production of non-native lexical stress during a reading task. We expected that showing gestures during training would be more beneficial than providing audio-visual information without gestures (H1) and that the type of gesture used during training matters, in that metaphoric gestures would be more beneficial than beat gestures (H2). Although the descriptives support the direction of our hypotheses, the multinomial logistic regression analysis reveals that the difference between the three gesture conditions is not significant for the outcome in which learning takes place, which is of most interest for this study. This is in line with those prior studies that did not find an effect of gestural training in the context of L2 (supra)segment acquisition [14, 15, 16]. The absence of a significant difference between gesture conditions might be explained in several ways. Starting with the study that is perhaps most similar to ours, Zhang, Baills and Prieto [24] investigated the effect of hand clapping on lexical stress production by Chinese learners of French. Interestingly, they found a significant improvement between pre and post-test for the clapping condition when examining relative syllable durations, but no significant difference for accentedness ratings. This might imply that while acoustic measurements can provide enough detail to distinguish between pre and post-test in the clapping condition, the differences between stress pattern productions during the pre-test and post-test might not be salient enough for rating-based analyses. The current results are also based on ratings in the sense that coders determined whether productions by participants were on-target or not and, while they agreed almost perfectly in their judgments, it might be the case that a binary distinction is not sufficiently refined to grasp the differences in lexical stress placement patterns produced by L2 learners in this context.

Furthermore, while it is unlikely that our design lacks statistical power, the training that participants received was quite short and directly followed by the post-test. Due to time constraints, the L2 learners were only exposed to one example item per rule (i.e., three examples in total) and not required to practice the rules before starting the post-test. In a follow-up study, this will be expanded to two example items and one practice

item per rule, in order to present participants with the opportunity to familiarise themselves more thoroughly with the lexical stress rules of Spanish before taking the post-test. Moreover, by adding two conditions in which participants perform either the beat or metaphoric gesture themselves, we hope that they become even more aware of the prosodic differences between unaccented and accented syllables.

Likewise, the number of training sessions might be relevant in this context. In the current study, participants received only one training session, whereas it might be the case that a possible facilitating effect of gestural training does not become apparent in the short term but requires a longitudinal approach. As most other research on the beneficial effect of gestures on L2 acquisition is also characterized by a single input moment instead of repeated exposure to the stimuli, we currently cannot determine whether adding additional training sessions might lead to more pronounced differences between the gesture conditions and thus result in an effect of gesture condition. This presents a challenge for future work on this topic.

We did find a significant effect of the presence vs. absence of a written accent in the experimental item on training outcome. More specifically, the cases in which Dutch learners of Spanish were never able to produce accurate lexical stress patterns were predominantly those with a written accent. Conversely, the majority of the cases in which participants were already able to accurately produce the item at T1 and continued to do so at T2 were items without a written accent. This implies that items with a written accent are especially challenging for learners, whereas items without a written accent are relatively easy. This might be surprising, considering the fact that a visual cue such as a written accent explicitly guides the learner as to which syllable is to be emphasised within the word. However, it does corroborate prior research which shows that the specific context in which L2 phonology acquisition does or does not occur matters when it comes to the facilitating role of gestures [12, 15, 28]. In addition, the use of cognates, while alleviating semantic processing load, does result in the use of less balanced item lists. For most items with a written accent, the antepenultimate syllable was to be emphasised, whereas in the items without a written accent it was usually the (pen)ultimate syllable that was to receive lexical stress. This difference presents a possible confound of this factor in our design and might explain the abovementioned difference between the Always Able and Never Able training outcomes. Yet it is impossible to avoid this possible confound without resorting to non-cognates and thus increasing the semantic processing load for the participants.

To summarise, the current study was not able to provide conclusive findings with regard to the possible facilitating effect that different types of gesture may have on L2 lexical stress acquisition. As was the case in previous related work, some of the results do suggest that (some) gestures may play a role in facilitating L2 acquisition, yet this finding is far from straightforward. In our case, we saw that item characteristics, namely whether they contained a written accent or not, played a larger role in predicting whether there would be learning of the Spanish lexical stress rules than the gesture condition the participant was in. However, the question to what extent this also means that different types of gestures during training can never facilitate the acquisition of L2 lexical stress by Dutch learners of Spanish remains to be answered in future research.

5. Acknowledgements

The authors are grateful to Núria Domínguez, for her assistance in material preparation.

6. References

- [1] A. Kendon, *Gesture. Visible action as utterance*. Cambridge: Cambridge University Press, 2004.
- [2] D. McNeill, *Hand and mind. What gestures reveal about thought*. Chicago: University of Chicago Press, 1992.
- [3] R. Zwaan, "The immersed experienter: Toward an embodied theory of language comprehension," *Psychology of Learning and Motivation*, vol. 44, pp. 35–62, 2004.
- [4] A. Yeo, S. Wagner Cook, M.J. Nathan, V. Popescu, and M. Alibali, "Instructor gesture improves encoding of mathematical representation," in T. T. Rogers, M. Rau, X. Zhu, and C. W. Kalish (Eds.), *40th Annual Conference of the Cognitive Science Society, Austin, Texas, Proceedings*, 2018, pp. 2723–2728.
- [5] J.M. Iverson, and S. Goldin-Meadow, "Gesture paves the way for language development," *Psychological science*, vol.16, no. 5, pp. 367–371, 2005.
- [6] M.L. Rowe, S. Özçalışkan, and S. Goldin-Meadow, "Learning words by hand: Gesture's role in predicting vocabulary development," *First Language*, vol. 28, no. 2, pp. 182–199, 2008.
- [7] S.D. Kelly, T. McDevitt, and M. Esch, "Brief training with co-speech language lends a hand to word learning in a foreign language," *Language and Cognitive Processes*, vol. 24, no. 2, pp. 313–334, 2009.
- [8] M. Tellier, "The effect of gestures on second language memorisation by young children," *Gesture*, vol. 8, no. 2, pp. 219–235, 2008.
- [9] J. Anderson-Hsieh, R. Johnson, and K. Koehler, "The relationship between native speaker judgments of nonnative pronunciation and deviance in segmentals, prosody, and syllable structure," *Language Learning*, vol. 42, no. 4, pp. 529–555, 1992.
- [10] J. Caspers, and K. Horloza, "Intelligibility of non-natively produced Dutch words: Interaction between segmental and suprasegmental errors," *Phonetica*, vol. 69, no. 1-2, pp. 94–107, 2012.
- [11] M.J. Munro, and T.M. Derwing, "Foreign accent, comprehensibility, and intelligibility in the speech of second language learners," *Language Learning*, vol. 49, pp. 285–310, 1999.
- [12] Y. Hirata, S.D. Kelly, J. Huang, and M. Manansala, "Effects of hand gestures on auditory learning of second-language vowel length contrasts," *Journal of Speech, Language, and Hearing Research*, vol. 57, no. 6, pp. 2090–2101, 2014.
- [13] B. Hannah, Y. Wang, A. Jongman, and J.A. Sereno, "Cross-modal association between auditory and visual-spatial information in Mandarin tone perception," *The Journal of the Acoustical Society of America*, vol. 140, no. 4, pp. 3225–3225, 2017.
- [14] Y. Hirata, and S.D. Kelly, "Effects of lips and hands on auditory learning of second-language speech sounds," *Journal of Speech, Language, and Hearing Research*, vol. 53, no. 2, pp. 298–310, 2010.
- [15] S.D. Kelly, A. Bailey, and Y. Hirata, "Metaphoric gestures facilitate perception of intonation more than length in auditory judgments of non-native phonemic contrasts," *Collabra: Psychology*, vol. 3, no. 1, pp. 7, 2017.
- [16] S.D. Kelly, Y. Hirata, M. Manansala, and J. Huang, "Exploring the role of hand gestures in learning novel phoneme contrasts and vocabulary in a second language," *Frontiers in Psychology*, vol. 5, pp. 1–11, 2014.
- [17] S. McCafferty, "Gesture and the materialization of second language prosody," *IRAL - International Review of Applied Linguistics in Language Teaching*, vol. 44, no. 2, pp. 197, 2006.
- [18] E. Krahmer, and M. Swerts, "The effects of visual beats on prosodic prominence: acoustic analyses, auditory perception and visual perception," *Journal of Memory and Language*, vol. 57, pp. 396–414, 2007.
- [19] D. Loehr, "Temporal, structural, and pragmatic synchrony between intonation and gesture," *Laboratory Phonology*, vol. 3, no. 1, pp. 71–89, 2012.
- [20] P. Wagner, Z. Malisz, and S. Kopp, "Gesture and speech in interaction: An overview," *Speech Communication*, vol. 57, pp. 209–232, 2014.
- [21] N. Esteve-Gibert, and P. Prieto, "Prosodic structure shapes the temporal realization of intonation and manual gesture movements," *Journal of Speech, Language, and Hearing Research*, vol. 56, pp. 850–864, 2013.
- [22] D. Gluhareva, and P. Prieto, "Training with rhythmic beat gestures benefits L2 pronunciation in discourse-demanding situations," *Language Teaching Research*, vol. 21, no. 5, pp. 609–631, 2017.
- [23] A. Zheng, Y. Hirata, Y., and S.D. Kelly, "Exploring the effects of imitating hand gestures and head nods on L1 and L2 Mandarin tone production," *Journal of Speech, Language, and Hearing Research*, vol. 61, no. 9, pp. 2179–2195, 2018.
- [24] Y. Zhang, F. Baills, and P. Prieto, "Hand-clapping to the rhythm of newly learned words improves L2 pronunciation: Evidence from training Chinese adolescents with French words," *Language Teaching Research*, 2018.
- [25] A.L. Hubbard, S.M. Wilson, D.E. Calla, and M. Dapretto, "Giving speech a hand: Gesture modulates activity in auditory cortex during speech perception," *Human Brain Mapping*, vol. 30, pp. 1028–1037, 2009.
- [26] J.A.B. Bernard, Z. Millman, and V.A. Mittal, "Beat and metaphoric gestures are differentially associated with regional cerebellar and cortical volumes," *Human Brain Mapping*, vol. 36, no. 10, pp. 4016–4030, 2015.
- [27] B. Hannah, Y. Wang, A. Jongman, and J.A. Sereno, "Cross-modal association between auditory and visual-spatial information in Mandarin tone perception," *The Journal of the Acoustical Society of America*, vol. 140, no. 4, pp. 3225–3225, 2017.
- [28] L. Van Maastricht, M. Hoetjes, and L. van der Heijden, "Multimodal training facilitates L2 phoneme acquisition: An acoustic analysis of Dutch learners' segment production in Spanish," *International Congress of Phonetic Sciences, 5-9 August, Melbourne, Australia, Proceedings*, 2019.
- [29] M. Ortega-Llebaria, "Phonetic cues to stress and accent in Spanish," *2nd conference on laboratory approaches to Spanish phonetics and phonology, Proceedings*, 2006, pp. 104–118.
- [30] M. Ortega-Llebaria, and P. Prieto, "Acoustic correlates of stress in Central Catalan and Castilian Spanish," *Language and Speech*, vol. 54, no. 1, pp. 73–97, 2011.
- [31] P. Boersma, and D. Weenink, "Praat: doing phonetics by computer" [Computer program]. Version 6.0.43, retrieved 8 September 2018 from <http://www.praat.org/>.